



Competency 4.5 Radiation protection personnel shall demonstrate a working level knowledge of Department of Energy and contractor radiological control programs and develop criteria for evaluating the readiness of a radiological protection program.

1 Supporting Knowledge and/or Skills

- a. Discuss the factors that influence the scope and magnitude of a radiological protection program for a site/facility including:
 - Specific facility mission
 - Types and quantities of radioactive material in use at the site/facility
 - Physical and chemical forms of the radioactive material
 - Physical location of the site/facility in relation to population centers
 - Size of the workforce
 - Age of the facility
 - Original facility design criteria
- b. Develop specific criteria for evaluating the readiness of a radiological protection program for the following areas:
 - Management Oversight
 - Radiological Protection Organization
 - Training
 - Reviews, Audits, and Evaluations
 - Radiological Protection Organization's Oversight of Radiological Design Criteria
 - Radiological Safety Work Practices and Administrative Controls
 - Radioactive Materials Control
 - Dosimetry Program
 - Radiological Safety Instrumentation and Alarms
 - X-Ray and Source Radiography
 - Workplace Surveys and Monitoring
 - Reporting
 - Development of Radionuclide-Specific Guidance
 - Radiation-Producing Machines



- Radiological Accidents and Emergency Response
- Records Maintenance Requirement
- Conduct of Operations as Related to Radiological Protection
- Data and Trend Analysis

2. Summary

10 CFR 835, *Occupational Radiation Protection*, codifies existing DOE radiation protection directives. The final rule became effective 30 days after its publication in the *Federal Register* on Dec. 14, 1993. This regulation establishes requirements for radiation protection of occupational workers at DOE facilities with the intent of ensuring that radiation exposures are kept not only within applicable limits, but as far below these limits as is reasonably achievable. Because DOE recognized that initially meeting the requirements of Part 835 would be difficult, the final rule required the submission of a radiation protection program (RPP) by Jan. 1, 1995, that would set "forth the plans, schedules, and other measures for achieving compliance with the requirements of this final rule by Jan. 1, 1996." The RPP is designed to describe those actions that will demonstrate full compliance with 10 CFR 835.

10 CFR 835, however, does not address every essential area needed to form the basis of a comprehensive program for protection of individuals from the hazards of ionizing radiation in the workplace. Therefore, DOE has issued a Notice (DOE N 441.1) to establish radiological protection requirements that, combined with 10 CFR 835 and its associated implementation guidance, form the basis for a comprehensive RPP.

The development of an adequate RPP is strengthened by examining and utilizing the subparts in 10 CFR 835. Each subpart addresses a particular aspect related to radiation protection. Evaluating the readiness of an RPP entails the use of criteria as benchmarks for its success. The subparts found in Part 835 are useful not only for designing an RPP, but for developing criteria to assess the program as well. In addition, DOE/EH-0256T (Revision 1), *Radiological Control Manual*, contains detailed guidance that can be used to formulate an extended list of criteria for evaluating the adequacy and completeness of an RPP.

3. Self-Study Scenarios/Activities and Solutions

Review

- 10 CFR 835, *Occupational Radiation Protection*.
- DOE N 441.1, *Radiological Protection for DOE Activities*.
- DOE/EH-0256T (Revision 1), *Radiological Control Manual*.



Scenario 1, Part A

A DOE M&O contractor, whose primary missions involve medical research, training, and environmental assessments of formerly remediated sites, maintains four buildings that contain radioactive materials. The hazards associated with operations involving these materials are viewed as minimal and could be characterized as those similar to a hospital or academic research setting. The majority of the radioactive material at the contractor's facility consists of low-level alpha, beta, and beta-gamma sources; sealed gamma and neutron sources; and tritium and carbon-14 labeled compounds. The typical annual inventory is in the microcurie to millicurie range. In performing their mission for DOE, the M&O contractor's employees routinely receive occupational exposures that are less than 100 mrem annually.

The contractor's facility was established in the 1940s with a workforce of 100. The original facility design criteria was for medical research and training. Today, the contractor employs 1,000 full-time employees, 100 of which are monitored radiation workers. The facility is located in a small town with a population of approximately 30,000 and is 30 miles from a population center of approximately 300,000.

Discuss the factors that influence the scope and magnitude of this facility's RPP.

Your Solution:



Scenario 1, Part A Solution

(Any reasonable paraphrase of the following is acceptable.)

The scope, magnitude, and effectiveness of an RPP will vary from site to site and facility to facility based on many factors. For this scenario, these factors include, but are not limited to:

Specific facility mission

- Training.
- Medical research.
- Assessments of formerly remediated sites.

Types and quantities of radioactive material in use at the site/facility

- A variety of radioactive materials, which emit alpha particles, beta particles, photon radiations (x-rays and gamma rays), and neutrons, are used at this facility.
- Microcurie to millicurie levels of radioactivity make up the majority of the facility's annual inventory.

Physical and chemical form of the radioactive material

- The majority of the radioactive material consists of radiolabeled tritium and carbon-14 for medical experiments and both sealed and unsealed sources for training and environmental.

Physical location of the site/facility in relation to population centers

- The facility is located in a town of 30,000 and 30 miles from a population center of 300,000.

Size of the workforce

- The contractor employs 1,000 people.
- One hundred (10%) of these employees are monitored radiation workers.

Age of the facility

- The facility is in excess of 50 years old; therefore, the original design criteria are less stringent than current standards. DOE Order 6430.1A, *General Design Criteria*, should be examined to assist in overcoming any deficiencies that would lessen the effectiveness of the RPP.



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Scenario 1, Part B

Develop specific criteria to evaluate the readiness of this facility's RPP.

Your Solution:

[illegible]



Scenario 1, Part B Solution

(Any reasonable paraphrase of the following is acceptable.)

Evaluating the readiness of an RPP is a complex task that requires, among other things, the formulation of numerous criteria. As mentioned earlier, examining and utilizing the subparts in 10 CFR 835 in addition to the guidance found in the DOE *Radiological Control Manual* are positive steps towards accomplishing this objective.

The following subparts are noted in Part 835:

- Subpart A - General Provisions
- Subpart B - Radiation Protection Programs
- Subpart C - Standards for Internal and External Exposure
- Subpart D - [Reserved]
- Subpart E - Monitoring in the Workplace
- Subpart F - Entry Control Program
- Subpart G - Posting and Labeling
- Subpart H - Records
- Subpart I - Reports to Individuals
- Subpart J - Radiation Safety Training
- Subpart K - Design and Control
- Subpart L - Releases of Material and Equipment from Radiological Areas
- Subpart M - [Reserved]
- Subpart N - Accidents and Emergencies

Note that examining just the titles of these subparts raises, in most cases, issues and questions that can be used as a foundation for developing detailed criteria. Examining the sections that follow each particular subpart are of even greater assistance in this regard.

The DOE *Radiological Control Manual* is a very useful guidance document that should be utilized to develop criteria. The information provided in this reference alone can generate hundreds of general and detailed questions regarding the effectiveness and readiness of an RPP. The reader is encouraged to use the DOE *Radiological Control Manual*, 10 CFR 835, and other references that are available within the DOE complex to formulate relevant criteria.



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The rest of the solution that follows is not intended to fully satisfy the supporting knowledge and skill noted under Competency 4.5. Rather, it serves as an example of particular areas and issues that likely would be of interest in an evaluation of an RPP such as the one described for the facility identified in the scenario. The intent, then, is to list a topic, identify an objective related to that topic, and then offer one or more criteria related to that objective. The reader should develop additional criteria either in the form of a statement or question.

NOTE: Because the DOE *Radiological Control Manual* is now considered a guidance document, the word "shall" has been "should" (or equivalent) in the following sections where it is referenced in formulating criteria.

Topic: Characterization

Objective: The potential radiation hazards for this facility have been adequately characterized, including radiation types and energies, and contamination potential.

Criteria:

- 1) Radiological monitoring of radiation exposure levels, contamination, and airborne radioactivity should be conducted to characterize workplace conditions and to identify areas requiring posting (DOE *Radiological Control Manual*, Article 551.1).
- 2) Assessment of radiological conditions should include a sufficient number of survey points to characterize the radiation present and to verify boundaries (DOE *Radiological Control Manual*, Article 551.6).
- 3) For external radiation, the types, energies, and spatial distribution of radiation sources should be identified. Other considerations may include the time spent in specified exposure conditions, training of workers for specific tasks, the degree of supervision, and the general layout of the working area (*International Atomic Energy Agency [IAEA] Safety Series No. 14*, Section 3.4.1).



Topic: ALARA Review

Objective: An ALARA evaluation has been performed including person-rem estimates for each evolution of the process or category of worker. This evaluation has been documented.

- Criteria:
- 1) Formal plans and measures shall be used to ensure that occupational radiation exposures are maintained ALARA (DOE 10 CFR 835, Subpart B, Section 835.101).
 - 2) Technical requirements for the conduct of work, including construction, modifications, operations, maintenance, and decommissioning, should incorporate radiological criteria to ensure safety and maintain radiation exposures ALARA. To accomplish this, the design and planning processes should incorporate radiological considerations in the early planning stages. The checklist in Appendix 3A of the DOE *Radiological Control Manual* is helpful in reducing occupational radiation exposure (DOE *Radiological Control Manual*, Section 311).

Topic: Engineering Controls

Objective: Appropriately designed engineering controls have been incorporated. These controls are documented.

- Criteria:
- 1) The enclosure system, including its internal and external support structures, shall be designed to withstand the effects of normal operating conditions and the environment (DOE Order 6430.1A, *General Design Criteria*, Section 1161).
 - 2) Engineering controls, including containment of radioactive material at the source wherever practicable, should be the primary method of minimizing airborne radioactivity and internal exposure to workers (DOE *Radiological Control Manual*, Article 316.1).
 - 3) Engineering controls, such as containment devices, portable or auxiliary ventilation, and temporary shielding, should be installed in accordance with the technical work documents and inspected prior to use (DOE *Radiological Control Manual*, Article 342.4).
 - 4) Processes and activities with the potential for producing airborne radioactivity should include engineering controls to limit releases (DOE *Radiological Control Manual*, Article 453.1).



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Topic: Instrumentation

Objective: The radiation monitoring instrumentation (air monitoring, contamination monitoring, and direct survey equipment) selected for use is appropriate for the radiation hazards identified.

- Criteria:**
- 1) Appropriate stationary (area) and/or portable radiation monitoring instruments shall be available and used to measure dose rates for the purpose of controlling exposure to radiation. These instruments shall be routinely calibrated and maintained. The combination of instruments used shall provide the capability to measure types of radiation and dose rates characteristic of that which could be encountered at that facility (10 CFR 835, Subpart E, Section 835.401).
 - 2) Instruments and techniques used to provide contamination monitoring and control shall be adequate to ensure compliance (10 CFR 835, Subpart E, Section 835.404).
 - 3) Instruments used to perform radiation surveys should be response-checked daily or prior to operation. When response checks are not within ± 20 percent of the expected value, the instrument should be taken out of service. When response checks are not feasible, such as with instruments used to measure neutrons or tritium, compensatory actions should be established to ensure proper instrument performance (DOE *Radiological Control Manual*, Article 551.5).
 - 4) Radiological instruments should be used only to measure the radiation for which their calibrations are valid. DOE Order 5480.4 mandates the requirements contained in American National Standards Institute N 323 for radiological instrumentation calibration. Calibrations shall use National Institute of Standards and Technology (NIST) traceable sources (DOE *Radiological Control Manual*, Article 562.1).

Topic: Radiological Surveys

Objective: Routine radiological surveys (contamination, airborne radioactive materials, and direct radiation) for this operation are defined and are adequate to detect potential increases in radiation hazards.

- Criteria:**
- 1) Occupational workers shall be monitored, as appropriate, to demonstrate compliance with the regulations. Workplaces shall be routinely monitored, as appropriate, for identification and control of potential exposure sources (10 CFR 835, Subpart E, Section 835.401).



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- 2) Surveys for radiation, contamination, and airborne radioactive materials should be performed as specified in technical work documents and Radiological Work Permits (DOE *Radiological Control Manual*, Article 551.3).
- 3) Survey frequencies should be established based on potential radiological conditions, probability of change in conditions, and area occupancy factors (DOE *Radiological Control Manual*, Article 551.8).

Topic: External Dosimetry

Objective: Personnel dosimetry is adequate for the radiation hazards associated with this facility.

- Criteria:
- 1) Personnel external dosimetry programs shall be adequate to demonstrate compliance. Personnel dosimeters shall be routinely calibrated (10 CFR 835, Subpart E, Section 835.402).
 - 2) The DOE Laboratory Accreditation Program (DOELAP) shall be maintained consistent with the applicable DOE standards, and dosimetry programs shall be accredited at periodic intervals consistent with the standards (DOE Notice 441.1, Section 6g).

Topic: Internal Dosimetry

Objective: Internal dosimetry considerations have been evaluated and baseline data are available for the workers associated with this facility.

- Criteria:
- 1) Internal dose evaluation programs (including routine bioassay programs) shall be adequate to demonstrate compliance (10 CFR 835, Subpart E, Section 835.402).
 - 2) Baseline bioassay monitoring of personnel who are likely to receive intakes resulting in a committed effective dose equivalent greater than 100 mrem should be conducted before personnel begin work that may internally expose them to radiation (DOE *Radiological Control Manual*, Article 522.2).



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Topic: Personnel Protective Equipment and Controls

Objective: Adequate personnel protective equipment (including protective clothing) and controls are available.

- Criteria:**
- 1) Personnel who work in a hazardous environment (e.g., an environment subject to radioactive gases and airborne particulates) or who may be temporarily exposed to such hazards shall have convenient access to the appropriate protection equipment, including proper garments, equipment such as emergency showers and eyewashes, and any other protective equipment necessary for the successful and safe completion of their work (DOE Order 6430.1A, Section 1300-12.4.5).
 - 2) The following controls apply to glove box operations (DOE *Radiological Control Manual*, Article 347.4):
 - a. Glove boxes should be inspected for integrity and operability prior to use.
 - b. Glove boxes should be marked or survey measurements should be posted to identify whole body and extremity dose rates.
 - c. Protective clothing shall, at a minimum, include lab coats and gloves. Gloves should be secured at the wrist as necessary.
 - d. Shoe covers should be considered based on the potential for floor contamination.
 - e. Workers should periodically monitor their hands during work.
 - f. Upon completion of work or prior to leaving the area, workers should monitor those areas of their bodies that are potentially contaminated. At a minimum, this includes hands, arms, and feet. Workers should perform a whole-body frisk.

Topic: Work Procedures

Objective: Work procedures have been reviewed by radiation safety professionals and have the appropriate radiation protection hold points, trigger points, and actions identified.

- Criteria:**
- 1) The site-specific Radiological Control Manual should establish trigger levels requiring formal radiological review of nonroutine or complex work activities. These appropriate trigger levels, taken from the DOE *Radiological Control Manual*, Article 312.3, should include:
 - a. Estimated individual or collective dose greater than preestablished values
 - b. Predicted airborne radioactivity concentrations in excess of preestablished values



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- c. Work area removable contamination greater than 100 times the values in Table 2-2 of the DOE *Radiological Control Manual*
 - d. Entry into areas where dose rates exceed 1 rem/hour
 - e. Potential radioactive releases to the environment
- 2) Tasks with the potential to exceed the above trigger levels should undergo a formal, documented radiological or ALARA review. This review should consider the following (DOE *Radiological Control Manual*, Article 312.4):
- a. Inclusion of radiological control hold points in the technical work documents
 - b. Elimination or reduction of radioactivity through line flushing and decontamination
 - c. Use of work processes and special tooling to reduce time in the work area
 - d. Use of engineered controls to minimize the spread of contamination and generation of airborne radioactivity
 - e. Specification of special radiological training or monitoring requirements
 - f. Use of mock-ups for high exposure or complex tasks
 - g. Engineering, design, and use of temporary shielding to reduce radiation levels
 - h. Walkdown or dry-run of the activity using applicable procedures
 - i. Staging and preparation of necessary materials and special tools
 - j. Maximization of prefabrication and shop work
 - k. Review of abnormal and emergency procedures and plans
 - l. Identification of points where signatures and second-party or independent verifications are required
 - m. Establishment of success or completion criteria, with contingency plans to anticipate difficulties
 - n. Development of a pre-job estimate of collective dose to be incurred for the job
 - o. Provisions for waste minimization and disposal
- 3) Radiological work activities should be conducted as specified by the controlling technical work document and radiological work permit (DOE *Radiological Control Manual*, Article 341.1).



Topic: Radiological Maintenance

Objective: The performance of expected maintenance has been reviewed for radiological concerns, and appropriate controls are in place.

- Criteria:**
- 1) Ease of maintenance and decontamination and decommissioning is to be considered in facility design and selection of materials (10 CFR 835, Subpart K, Section 835.1002).
 - 2) Technical requirements for the conduct of work, including construction, modifications, operations, maintenance, and decommissioning should incorporate radiological criteria to ensure safety and maintain radiation exposures ALARA (DOE *Radiological Control Manual*, Article 311).
 - 3) Maintenance and modification plans and procedures should be reviewed to identify and incorporate radiological requirements, such as engineering controls and dose and contamination reduction considerations (DOE *Radiological Control Manual*, Article 312.1).
 - 4) Preventive maintenance and surveillance procedures should be established to ensure that equipment controls are maintained in an operable condition for containment of airborne radioactivity (DOE *Radiological Control Manual*, Article 453.3).

Topic: Radiological Emergencies

Objective: Potential radiological emergencies are planned for in the design of support equipment, and documented action plans/procedures are in place.

- Criteria:**
- 1) The site-specific Radiological Control Manual should establish trigger levels requiring formal radiological review of nonroutine or complex work activities. These appropriate trigger levels should include (DOE *Radiological Control Manual*, Article 312.3):
 - a. Estimated individual or collective dose greater than preestablished values
 - b. Predicted airborne radioactivity concentrations in excess of preestablished values
 - c. Work area removable contamination greater than 100 times the values in Table 2-2 of the DOE *Radiological Control Manual*
 - d. Entry into areas where dose rates exceed 1 rem/hour
 - e. Potential radioactive releases to the environment



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- 2) Tasks with the potential to exceed the above trigger levels shall undergo a formal, documented radiological or ALARA review. At a minimum, this review should consider abnormal and emergency procedures and plans (DOE *Radiological Control Manual*, Article 312.4).

Topic: Roles and Responsibilities

Objective: Roles and responsibilities concerning radiation protection have been clearly identified and communicated.

- Criteria:
- 1) Radiological control technicians and their supervisors should have the responsibility and authority to stop work or mitigate the effect of an activity if they suspect that the initiation or continued performance of a job, evolution, or test will result in the violation of radiological control standards or result in imminent danger or unacceptable risk. Any worker, through his/her supervisor, also has stop-work authority in accordance with Article 345 (DOE *Radiological Control Manual*, Article 144.2).
 - 2) Good radiation safety practice depends on an effective health and safety organization. Experience shows that even the most competent worker cannot be relied upon to keep in mind all health and safety requirements while preoccupied with the successful performance of his/her work. Responsibilities and duties must be set out clearly to ensure safety (IAEA *Safety Series No. 1*, Section 1.4.1).
 - 3) The lines of responsibility in all matters connected with radiation safety should be very clearly drawn, and each individual should be aware of his/her duties and responsibilities (IAEA *Safety Series No. 38*, Section 21.2.4).

Topic: Training

Objective: Workers have received the appropriate training, including Radiological Worker training and job-specific radiation protection and monitoring criteria.

- Criteria:
- 1) The training should emphasize procedures specific to an individual's job assignment (10 CFR 835, Subpart J, Section 835.902).
 - 2) Radiological Worker II training is warranted for entry into areas as stated in Table 6-1 of the DOE *Radiological Control Manual*. Additional training should be strongly considered for special job functions with radiological consequences (DOE *Radiological Control Manual*, Article 631.2).



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- 3) Workers whose job assignments involve entry to High and Very High Radiation Areas, Contamination Areas, High Contamination Areas, and Airborne Radioactivity Areas should complete Radiological Worker II training. Further, workers who have potential contact with hot particles or use of glove boxes with high contamination levels should complete Radiological Worker II training (DOE *Radiological Control Manual*, Article 632.1).
- 4) Monitoring should be performed only by trained and qualified personnel using properly calibrated instruments (DOE *Radiological Control Manual*, Article 551.2).

Topic: Internal Audits

Objective: An internal audit program is developed and appropriate for review of the facility's operations.

- Criteria:
- 1) Contractor internal audits of all functional elements of the RPP shall be conducted no less frequently than every three years and shall include program content and implementation (10 CFR 835, Subpart B, Section 835.102).
 - 2) The internal appraisal system shall provide for objective and independent review of environment, safety, and health functions to determine that they are conducting reviews of: (1) proposed modifications to plant and equipment having safety significance; (2) proposed experiments and results thereof having safety significance; (3) procedures and significant changes to administrative, operating (normal and abnormal) maintenance, quality assurance (as it applies to Subparagraph 7), and emergency; (4) organizations and staffing of each facility; (5) operating limits, changes thereto, and violations thereof; (6) operator and supervisor training programs, certification, and decertification standards and procedures; and (7) accidents, incidents, and unusual occurrences (DOE Order 5482.1B, Section 09.D(2)(G)).

Topic: Records

Objective: Radiation monitoring and protection standards are adequate and appropriate.

- Criteria:
- 1) Records associated with the RPP shall be generated and maintained (10 CFR 835, Subpart H, Section 835.701).
 - 2) Radiological records should be in accordance with the DOE *Radiological Control Manual*, Chapter 7.



4. Suggested Additional Readings and/or Courses

Courses

NOTE: See Appendix B for additional course information

- DOE/EH-0450, *Radiological Assessors Training (for Auditors and Inspectors) Fundamentals of Radiological Control* -- Oak Ridge Institute for Science and Education
- *Radiation Protection Functional Area Qualification Standard Training* -- GTS Duratek.

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